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REVOLUTION IN COMPUTER SCIENCE AND ENGINEERING AND ITS IMPACT ON EVOLUTION OF HIGHER EDUCATION

Abstract

This presentation deals with analysis of main aspects and peculiarities of revolution in computer science, engineering and communications. Special attention paid to its correlation, intersection and impact to evolution of higher education systems with focuses on distance learning, computer-based languages learning, testing of student knowledge, internet of things, computer human-centered systems, learning games and so on. The role and perspectives of UIC - University-Industry Cooperation for improvement of higher education system based on the new achievements in computer science and engineering are discussed in details.

Introduction

Your Excellency, President Dr. Jaime Gil Aluja and Members of the Royal Academy of Economic and Financial Sciences of Spain, Distinguished Guests, Ladies and Gentlemen!.

It is with great pleasure that I have possibility to wish all of you great success on the occasion of this IX International Act *Evolution, Revolution and Involution in the Future of Social Systems*.

Let me cordially deliver a great friendship's feeling from the professors and students of Black Sea State University (Ukraine), from Regional Inter-University Centre in Mykolaiv and from Association of Ukrainian universities.

I think that today according to total revolution and evolution processes in different areas of human activity a lot of the same challenges and perspectives are common for different countries in the development of civil societies with high democratic transformations.

First of all it concern creating modern partner relations in main priority directions of science, exchange results and experience, taking into account revolution peculiarities in different spheres of human life, international experience and national specific of evolution processes.

Finally, in 21st century all revolution and evolution processes in any human activities should be turned to the perspective development of peace in the world, high level of human life, new achievements in science and culture.

General notifications and main conceptual focuses of revolution and evolution

The current topic of our IX International act is very important for undestanding and evaluation of modern revolution and evolution processes and their contribution to sustainable development of each society and to perspective future of world's social-economic system in whole.

At the same time, each component of this topic is very wide.

For example, if we say "revolution" we should take into account different revolution processes in Economics, Science and Engineering, Culture, Social-Economic and Social-Politic systems. According to Free encyclopedia (Wikipedia) notification [68] "a revolution (from the Latin *revolutio*, "a turn around") is a fundamental change in power or organizational structures that takes place in a relatively short period of time". But in general the "organizational structures" in such terminology may be widely transformed to "organizational, technological and intelligent structures and processes". And in this case the term "revolution" may be considered according to all abovementioned areas of human activity.

Early studies of historical revolutions primarily analyzed events from the psychological point of view. At the moment the most research deal with different focuses on revolution processes in more wide areas of human activity, such as sociology and political science, technology and engineering, including computer engineering and nanotechnology, medicine and intelligent studies, literature and philosophy, culture and so on.

If we say "evolution" we can consider all successive changes in the inherited characteristics of various dynamic processes in different areas of human activity, such as biology, education, society development, languages and so on. First of all, the most studies of evolution processes are based on the Charles Darwin theory [15], where a scientific argument was firstly formulated for the fundamental basis of "evolution" by means of natural selection.

Let's consider some examples of how the term "evolution" is used at the moment for the characterization of various dynamic processes in different fields of human activity. For instance, main aspects of the formation of the human specie as social being are considered in detail as evolution process in monograph [62]. Another example with using evolution conception is a discussion about the present state of political parties in Ukraine and possible lines of their evolution [28], where according to the opinion of Ihor Kohut the key feature of political parties' evolution in Ukraine is that by the method of formation, execution of constituent documents, registration, the logic internal systemic activity and specificity of participation in political processes that most of them follow and a former one-party model and pattern.

If we say "involution" we should take into account that involution occurs when something turns in upon itself [68]. This approach, for example, was used for studies and comparative analysis of Russia and China economy in [4]. The integrated analytic framwork for revolution, reform and involution under dictatorship based on the China's history is discussed in [49]. M.Burawoy (California University, Berkeley) considers the interaction between involution processes and market relations; S.Wang (Yale University) studies a transformation processes from revolution to involution and its impact to the state capacity, local power and govermentability. A good example is approach [53] based on the conception that physics model used in econophysics or sociophysics do not analyze only economic or social processes and phenomena but rather their continuity in evolution and involution. This new systemic approach involves new attitudes, ranging from acknowledging the differences between mental or intellectual models of econometrics and experimental models of physics, to repositioning the educational system and scientific research.

Analysis of Main Peculiarities of the Revolution in Computer Science, Engineering and Communications

In this presentation I'd like to consider in more details the main focuses of the Revolution in Computer Science and Engineering and its correlation, intersection and impact to evolution of higher education system taking into account perspectives for development of new pedagogic approaches, modern technical means for student's training and knowledge testing, etc.

Electronics and microelectronics affect modern societies in an extremely pervasive maner [41]. The impact is so relevant as to make electronic disciplines not only a technical or industrial topic but also a political and social issue. In [41] the authors discussed the key and controversial question about impact of high technology, in particular, electronics and microelectronics (E/ME) to society development and especially "may E/ME contribute to development?". The answer in not simple, direct and unique. It may be "yes" or "no" depends on policies followed and national and regional strategies [41].

Computing systems are going to be everywhere, embedded in all our everyday envirenments. We use personal computers and computer-based equipments and networks in our daily life for technological processes [34,35], office and smart house automation [73], for syntesis of music [8], for personal and group games, for applying computer-based robotic systems [29,63], for distance learning and communications, etc. And the role of new developments in computer science and computer engineering in our activities will growth year by year.

An information/communication revolution is being brought about by recent developments and innovations in computer and related technologies. Recognizes that many of the consequences will be very positive for all aspects of social life, but focuses on probable and possible negative effects of the currently accelerating cyberspace revolution. In [51] discusses ten problematical aspects for disaster planning, management and research ranging, for example, from the creation of a new kind of disaster (computer-related system failures) and the increased difficulties that will be generated for intra- and inter-organizational communication and coordination, to the problems that will come from an inevitable information overload and the diffusion of inappropriate or incorrect disaster relevant "facts" and "ideas".

Revolution in computer science and computer engineering has own peculiarities in different countries as after World War II, other major industrialized nations responded to the technological and industrial hegemony of the United States by developing their own design and manufacturing competence in digital electronic technology. During the 1980s US businesses poured billions of dollars [57] into computers and other information technology. In [65] John Vardalas describes the quest for such competence in Canada, exploring the significant contributions of the civilian sector but emphasizing the role of the Canadian military in shaping radical technological change as well as shows how national economic, political, and corporate forces influenced the content, extent, and direction of digital innovation in Canada. The case studies of such firms as Ferranti-Canada, Sperry Gyroscope of Canada, and Control Data of Canada are discussed in details. While underlining the unprecedented role of the military in the creation of peacetime scientific and technical skills, author [65] also examines the role of government and university research programs, including Canada's first computerized systems for mail sorting and airline reservations.

The introduction and diffusion of personal computers (PC) are widely viewed as a technological revolution. Using U.S. metropolitan area–level panel data, the author of the paper [2] asks whether links between PC adoption, educational attainment, and the return to skill conform to a model of technological revolutions in which the speed and extent of adoption are endogenous. The model implies that cities will adjust differently to the arrival of a more skill-intensive means of production, with the returns to skill increasing most where skill is abundant and its return is low.

In [48] discusses some of the future trends in the use of the computer in the society, suggesting that computing is now entering a new phase in which it will grow exponentially more powerful, flexible, and sophisticated.

Computing is leading a revolution, everything we do with using advanced computer systems is firstly in human history. At the moment it is real social computing revolution as we use computers for our work, play, communication, design, built, interaction with each other, learn and so on. So, computer technologies have a global impact to our daily lives. But sometimes we are happy with computer applications and sometimes we are not happy because some technologies we use is unfriendly, unnatural and difficult to use [20].

The promise of artificial intelligence and other branches of computer science is to radically transform conventional discovery environments by equipping scientists with a range of powerful computer tools including large-scale, shared knowledge bases and discovery programs. In [6] authors describe the future computer-supported discovery environments that may result, and illustrate by means of a realistic scenario how scientists come to new discoveries in these environments. In order to make the step from the current generation of discovery tools to computer-supported discovery environments developers should realize that such environments are large-scale sociotechnical systems.

Revolution in computer science and engineering provides a great jump in development and implementation of new intelligent methods, algorithms and systems (fuzzy sets and fuzzy logic, soft computing, neuro-technologies, ant colony and bee colony optimization, genetic algorithms, etc.) with wide range of practical applications [13,14,18,33,36,37,69,70]. This direction has very strong perspectives for future development.

Information modelling is concerned with design computer-based systems (in various applications) which capture the meaning of information and organize it in the ways that make it undestandable and useful for people [45]. Information modeling techniques can be clasified according to their ontologies, abstract mechanisms and tools they provide for building, analyzing and managing application models. Scientists from computer science pay and will pay a special attention to development of efficient information modeling techniques in the framework of knowledge representation, artificial intelligence, data mining, databases, data modeling, requirements analysis, software engineering, information systems and so on.

Agent-based modeling (ABM) has been gaining growing acceptance and enthusiasm in various fields of social science in recent years. Two questions are being asked in [1]: What are the reasons ABM is thought to be revolutionary, and what important next steps in developing ABM as a tool for social science are needed in order for this revolution to occur? In the social sciences, simulation may allow more aggressive exploration of the implications of, for example, imperfect rationality, the effects of learning and information, and social and institutional structure.

Computer networking is also really prospected research direction in computer science and engineering. An engineering approach to computer networking simultaneously studies all three major network technologies: (a) asynchronous transfer mode, (b) internet and (c) telephony. It is possible to analyze [25] the overviews of these technologies and extensive, up-to-date coverage of all essential networking topics: protocol layering; multiple access; switching; scheduling; naming, addressing, and routing; error and flow control; and traffic management.

Reading appliances allow people to work on electronic documents much as they would on paper. By integrating a wide variety of document activities, such as searching, organizing, and skimming, and by allowing fluid movement among them, reading appliances eliminate disruptive transitions between paper and digital media [54].

The structures of modern decision-making and decision support systems [38] in medicine, technical diagnostics, transport logistics and other fields mostly include computers or computer-based components. One among good examples is MYCIN - a medical computer-based system designed to assist physicians with clinical decision-making [56]. This system uses computer techniques derived principally from the subfield of computer science known as artificial intelligence.

The next step in the revolution initiated by the introduction of endoscopic surgery will be achieved by the introduction of robotics, telementoring systems and telepresence surgery [12]. Using computer-aided systems, such as robotics and image-guided surgery, the next generation of surgical systems will be more sophisticated, and will permit surgeons to perform surgical procedures beyond the current limitation of human performance - on the microscale, or on moving organs.

A computerized remote-controlled robot can be used to perform computer-enhanced major digestive laparoscopic surgery. Such experience is discribed in [66]. During a half of month (2001) 5 patients underwent laparoscopic sigmoidectomy, proctectomy, restoration of continuity after Hartmann operation, Whipple procedure, and right liver lobectomy. In each of the procedures, a remote-controlled robot was used to perform some stages of the surgery. During these stages, the surgeon was seated at a distance from the operating table and performed the surgery using the robot, which offers enhanced intracorporeal tool manipulation and spatial vision. For these 5 surgical procedures, laparoscopic computer-enhanced surgery seems safe and feasible. This introduction of computing to major digestive surgery opens the door to enhanced-reality surgery and new types of surgical education.

Research into computer-aided psychotherapy is thriving around the world. Most of it concerns computer-aided cognitive-behavioural therapy (CCBT). A recent narrative review found 97 computer-aided psychotherapy systems from nine countries reported in 175 studies, of which 103 were randomised controlled trials [42]. The rapid spread of the mass delivery of psychotherapy through CCBT, catalysed in the UK by the National Institute for Health and Clinical Excellence's recommendation of two CCBT programmes and the Department of Health's CCBT implementation guidance, seems unprecedented. The future directions of CCBT development are considered in [42] in details.

A lot of research projects and scientific investigations deal with an economic study of the revolution in information technology [23]. Computers prepare invoices, issue cheques, keep track of the movement of stocks and store personnel and payroll records. The spread of information technology is affecting the efficiency and competitiveness of business, the structure of the workforce, and the overall growth of economic output.

There have been three great revolutions in computing technology during the past 50 years [44]: (a) the stored-program computer, (b) high-level languages and (c) component-level programming. The component-level programming revolution has already happened in the academic community. The author in [44] looks into the future of component technology, explaining marketing flexibility and solutions to transmitting problems. Specialized elements of hardware and software, connected by wires, radio waves and infra-red will be realized with new component technology's solutions [67].

Author of [55] thinks that it's time we recognize that for the majority of world's population and for the foreseeable future cell phone is a computer. And really at the moment we have an international network of wirelessly-connected computers and a lot of software developers works for the improving corresponding hardware and software.

Researchers pay and will pay a lot of attention to forecasting of main stages of information technology revolution. Literature scan, Delphi surveys and interviews are used for forecasting development of computer engineering and information technology. Results, published in 1993 [16], show that highly advanced computer hardware should became commonly available about the year 2000, including a powerful new class of superchips, portable computers, parallel processor, public computer networks and possibly optical computers. Far more sophisticated software shoud be widely used at roughly the same time as expert systems, automatically generated programming, personal assistance and programs that enable computers to talk and to learn. The use of information services like telecommuting, electronic education, teleconferencing, and electronic shopping is also likely. All these developments as components of information technology revolution were predicted in 1993 and now, in 2014, we can see and can confirm that all abovementioned prognoses are successfully realised in moden computer and software engineering solutions.

The authors in [71,72] pay special attention to future changes in computer science, future changes in software engineering, as well as, argue that four main characteristics will distiguish future software systems from traditional ones, especially:

a) situatedness;

b) openness;

c) locality in control;

d) locality in interactions.

The next technological revolution deals with "Internet of Things" [64]. This term "Internet of Things" describes several technologies and research disciplines which enable the Internet to reach out into the real world of physical objects. Technologies such as short-range wireless communications, real-time localization and sensor networks are becoming increasingly pervasive, making the "Internet of Things" a reality. A wide range of researchers from academia and industry, as well as, businesses, government agencies and cities are exploring the technologies comprising the "Internet of Things" from 3 main perspectives: (a) scientific theory, (b) engineering design and (c) user experience in applications. At the moment, the "Internet of Things" represents the most potentially disruptive technological revolution of our lifetime. From 50 to 100 billion things expected to be connected to the Internet by 2020 [64] and it is a fact, that everyday objects become interconnected and intelligent.

Using a computer ought to be as easy and productive as driving a car. But today's systems are oblivious to our needs and demand ever more attention and work from us, as they swell in numbers, complexity and features. M.Dertouzos [7] argues that we must shift the focus of information technology away from machines and back to people. In [7] author offers exciting vision of how human-centered computers could dramatically alter the way we live and work in the information century.

Thus, at the moment and for the future a human-centered computing is very perspective direction in computer science as human-centered computing studies design, development and deployment of mixed-initiative computer system. Human-centered computing is emerging from the convergence of multiple disciplines that are concerned both with understanding human beings and with the design of computational artifacts [20]. The research groups for design of human-centered computing systems should include specialists with different background and knowledge in computer science, sociology, psychology, engineering, cognitive science, graphic and industrial design and so on.

Three main factors form a core and determine the design processes for human-centered computing systems:

a) individual human abilities and limitations;

b) social and cultural awareness;

c) adaptability across individuals and specific situations.

And finally human-centered computing systems should exibit such peculiarities and qualities as:

a) integrate input from different types of sensors and communicate throught a combination of media as output;

b) act according to the social and cultural context in which they are deployed;

c) be useful to deverse individuals in their daily life.

Advanced human-centered computing systems in future must be proactive, multimodal and easily accesible to a wide range of users. Such human-centered computing systems should provide, in particular:

a) understanding cultural and social contexts and responding accordingly;

b) processing inputs and outputs in a naturally rich communication channel.

The Evolution of Higher Education System and Online Learning

So, we are living in an information society and collecting, processing, and communicating information come to play an increasingly important role in advanced industrial countries relative to the roles of matter and energy [3].

At the same time, there is a very important aspect of the revolution in computer science and engineering concerning future impact of computers in changing our culture [52]. Special attention should be paid to the problem of computer literacy at the colleges and universities [10], to correction and modification of university's curricula based on the last scientific results and new achievements in computer science and engineering, as well as to preparation and publication efficient textbooks with new examples, exercises, and computer-based pedagogical materials [47].

Main aspects of the computer revolution in education are considered in [22] with focus to new technologies in distance learning.

Online learning is a new social process that is beginning to act as a comple substitute for both distance learning and the traditional face-to-face class.

Online learning is the latest in a long list of social technologies that have been introduced to improve distance learning by adding various augmentations, substitutions or blending of new pedagogical approaches and technologies. Modern technologies used for distance and online learning include:

- correspondence courses, printed matter and physical mail;
- telephone and audio recodings;
- TV and video recordings;
- computer-assisted instructions;
- asynchronouse and synchronouse group communications;
- the Web and multimedia materials;
- simulation and gaming;
- collaborative learning;
- ALN - asynchronous learning networks;
- collaborative knowledge systems;
- immersive simulations;
- wireless and handheld devices.

By 2004 at least 2 millions US students were involved in distance education process using different types of asynchronous learning networks. And in 2014, for example, University of Phoenix offers online associate degree programs, online bachelor's degree programs, more then 30 online master's degree programs and eight online doctoral degree programs which give students the flexibility to study at a time that's convenient for them.

In [17] authors argue that the current evolutionary changes in pedagogy and educational technologies are the revolutionary changes in the nature of higher education as a process and as a insitution. The modern higher education system in process of moving to online and hybrid courses using digital technologies to support constructivist, collaborative, student-centerd pedagogy, offered by several hundred advanced universities that operate on the global scale. Once most courses are available in digital formats as well as on campuses, geographic monopolies and barriers that have sustained thousands of different colleges and universities in Europe, USA and around the world will weaken.

The paper [5] summarizes a number of prospects and challenges arrising from the appropriation of digital technology to learning and educational practice. It was argued that new technology brings radical opportunities (home schooling, workplace learning, distance education, adult education, learning centres, computer games, Web communities, technical certifications, Internet cafes, but also significant challenges. Our technology leaders need to work together with educators, not as missionaries, but as collaborators in creating new opportunities to learn.

There is very important direction concerning conception of computer games and learning. Digital game-based learning [50] is the powerful learning tools with new learning opportunities for players learning from playing computers and video games.

Instructional technology and World Wide Web [24] offer powerful teaching resources that provide educators with a limitless wealth of information and shared professional practices.

The main challenges in distance education based on constructivism and computer-mediated communication [21] can be presented as following:

a) limitations of distance learning technologies;

b) recent evolution in learning and instructional design theory;

c) implications of constructivism to learning and instruction;

d) constructivism at a distance;

e) computer-mediated communication technologies;

f) computer-supported collaborative work;

g) situated, case-based learning environments;

h) cognitive tools for knowledge representation and construction.

All advances in computer science, engineering and communications very close deal with computer ethics. In [43] some arguments regarding the possible future disappearance of computer ethics as an autonomous discipline are discussed. In the future, there are two ways in which computer ethics might disappear:

a) the rejection of computer ethics as an aspect of applied ethics;

b) the rejection of computer ethics as an autonomous discipline.

The first path [43] would lead to the death of the entire field of applied ethics, while the second path would lead only to the death of computer ethics as a separate subject. Computer technology is becoming very pervasive, and each scientific field includes some discipline-specific computing. For the likely foreseeable future, disciplines such as bioethics and engineering ethics will have to deal with ethical issues involving the role of computers. Author of [43] argues that computer ethics in this sense is unlikely to disappear, even if computer ethics ceases to be considered as a separate discipline and as final conclusions:

a) applied ethics will not die, but it may make no sense in the future to talk about computer ethics as a separate field;

b) computer ethics will not simply become “ordinary ethics”, contrary to Johnson’s view.

Computer-Assisted Language Learning is the field concerned with the use of computer tools in second language acquisition.

Somewhat surprisingly, perhaps, this field has never been closely related to Computational Linguistics. Until recently, the two fields were almost completely detached. Despite occasional attempts to apply techniques of Natural Language Processing to the recognition of errors, Natural Language Processing in Computer-Assisted Language Learning has long remained in a very small minority position while Computer-Assisted Language Learning was hardly if at all recognized as a part of Computational Linguistics.

The discussion in [60] started from two questions, one of them directed to the past (why are Computational Linguistics and Computer-Assisted Language Learning traditionally separated?) and one to the future (why are the prospects of collaboration now better?). The relevant distinction between the past and the future is that a revolution in the field of Computational Linguistics has thoroughly changed the general approach.

Before the revolution Computational Linguistics concentrated on Natural-Language Understanding. Computer-Assisted Language Learning is not useful as a test for Natural-Language Understanding and Natural-Language Understanding components are at most marginally useful in Computer-Assisted Language Learning.

After the revolution, Computational Linguistics has turned to the detailed analysis of practical problems.

Computer-Assisted Language Learning provides an interesting set of such practical problems. A revolution does not mean that all earlier knowledge is lost. In fact, researchers try to save as much of it as possible by reinterpreting it in the new framework. Parsing techniques and theories of grammar are still used, but in a more interesting way than before.

Computer-Assisted Language Learning is likely to be among the typical fields of application of Computational Linguistics in the future.

The emergence of computerized adaptive tests, which customize assessment for each individual, may mean more efficient testing [19,40] and development of efficient computer-based testing systems for objective assesment of student's knowledge and is a very perspective direction in future for the field of computer applications in training process that, in other words, illustrates a strong correlation between computer science, computer engineering and higher education.

Taking into account that efficient energy production and consumption is a real-world problem, a lot of researchers' attention will be paid to creating reconfigurable- computing technology [46], green computing technologies [9,26] and corresponding software and hardware with further implementation of new research results to university's curricula and programs.

Perspectives of University-Industry Cooperation (UIC) for Improvement of Higher Education Systems Based on New Achievements in Computer Science and Engineering

Scientists from different countries contribute to revolution in computer science and engineering and in new communication technologies, as well as, to evolution of native higher education systems.

At the moment inter-university cooperation in the framework of academic consortia gives good collaboration results for improving educational technologies and training methodologies based on modern computer-based systems and Internet opportunities [30,31,32,39].

Strong and very perspective direction in this field (from the structure-organized point of view) is creating different industry-university groups, consortia or alliances for solving current and future problems in higher education by using mutual work experience in computer science, engineering and Internet-communications [11,61]. Our Black Sea State University (Mykolaiv, Ukraine) is a member of such international academic consortium which includes universities and different IT companies from Italy, Portugal, Spain, Sweden, Ukraine and United Kingdom. This consortium was established for development and implementation of the models A1, A2, B and C in university-industry cooperation [27,58,59] in the framework of TEMPUS-project 544497-TEMPUS-1-2013-1-UK-TEMPUS-JPHES "Model-oriented approach and Intelligent Knowledge–Based System for Evolvable Academia-Industry Cooperation in Electronics and Computer Engineering" (2013-2016).

For, example, such International forums as "University Industry Interaction Conference" (Amsterdam, 2013; Barcelona, 2014), "Higher Education Perspectives: The Role of Inter-University Consortia" (Mykolaiv, 2004) and others confirm paying a great attention to discussed UIC's problem from the international industry-education community.

At the current stage of educational transformation in Ukraine and other countries it is necessary to develop a clear conception and methodology concerning implementation of new research results and distinguish scientific achievements in modern computer and communication technologies to university's curricula and programs taking into account:

a) modern dynamics of society's economic development;
b) peculiarities of the corresponding region;
c) an increasing intellectual level of technologic and production processes;
d) complexity of market relations and labor market;
e) humanization and democratization of our societies.

UIC as a perspective method of flexible approach of higher educational system to society demands permission to create conditions for global realization of every young man's or woman's abilities in the economically emerging process based on freedom and democracy.

The realization of such targets deals with the necessary development of scientific-methodological basis for creating, managing and efficient functioning academic-industry consortia according to the principles of integration and cooperation between IT companies and universities with flexible forms of training process, curricula and programs that correspond to full realization of abilities and possibilities of each student and faculty.

The main future directions of research in the field of creating academia-industry consortia are:

- analysis and synthesis of the structure of academia-industry consortia and their status which provide flexible re-orientation of institutions for realization of potentialities of Science-to Business and Business-to-Science cooperation, taking into account special features of cultural, political and economic development of the corresponding region, actual demands at the labor market etc.;

- development of normative legislative documents for a mechanism of creating and functioning academia-industry consortia, as well as specific criteria and models [27] for their establishment;

- investigation of economic development and financial structure of consortia, cost sharing mechanism, criteria for evaluation of effectiveness, consortia fundraising, as well as, analysis of financial aspects of equipment, tools and financial-economic conditions, which are created to facilitate research and training processes at the academia-industry consortia;

- exploration of how can academia-industry consortia successfully share advanced technology and methods of cost-effectiveness in purchasing of education manual and advanced equipment, as well as, creation of common information network and organization of efficient digital library cooperation;

- investigation of psychological-education aspects of creating and functioning academia-industry consortia, analysis of psychological comparability of managers, researchers, project-developers, teachers, students and patterns of their behavior;

- analysis of possibilities to involve narrow specialists from advanced IT companies to teach multidisciplinary courses at the universities in the framework of academia-industry consortia;

- development of methodology of scientific-methodological cooperation among IT-companies and universities, which entered in a Consortium, in such fields as introduction of new information technologies, new educational methods using Internet opportunities for increasing motivation and efficiency of self-training student's work, bringing all attributes of educational activity to international standards, development of flexible module-type curricula with general training forms and methods, principles of evaluation system, electronic textbooks.

- determination of the principles of working together to improve students internship (practice) and teaching/learning in consortia environment including methodology of modern computer technologies for special training and development of new forms of training process within academia-industry consortia including curriculum structures, training programs with cycles of obligatory, special and elected courses.

No doubts that we should consolidate our scientific cooperation in the discussed field of UIC for mutual benefit and for sustinable development of our higher education systems and societies.

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Thank you very much for your attention.

Conclusions

The impact of revolution in computer science, engineering and communication to higher education systems evolution in different countries is great. The literature survey shows that intersection and correlation of such computer revolution and higher education evolution play a significant role and have very important perspectives in future both computer science and higher education, taking into account new developments in Online Learning, Internet of Things, Human-Centered Computing Systems and so on. No doubts, that UIC is the best collaborative mechanism for development, introduction and implementation of new scientific results and research achievements in computer science to higher education system, in particular, to university's curricula and programs.

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